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COMPARATIVE ANALYSIS OF WATER AND NANO FLUID IN STHE USING COMPUTATIONAL FLUID DYNAMICS

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ABSTRACT

In this current work, study has been conducted on the shell and tube heat exchanger. CFD was used to carry out the analysis of this heat exchanger. Fluent software was used to project the pressure distribution. The effectiveness of base fluid and nano fluid was simulated and compared. The base fluid used was water and nano fluid used for the analysis was Al_2O_3. Rate of heat transfer was inspected. It was established from the results that Al_2O_3 was more effective as compared to base fluid. The role of eddy viscosity had been also discussed.

KEYWORDS: STHE, Fluent, Pressure Distribution, ANSYS, Viscosity Distribution & Heat.

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Original Article

INTRODUCTION

The shell-and-tube heat exchangers (STHE) are still the most prevalent class in work. As compared to others, STHE have high A /V ratio. They can handle high pressures. STHE consists of a cylindrical shell with bundles of tubes inside. One fluid passes inside the tubes and other fluid passes within space between the tubes and shell. STHE is shown in Figure 1.

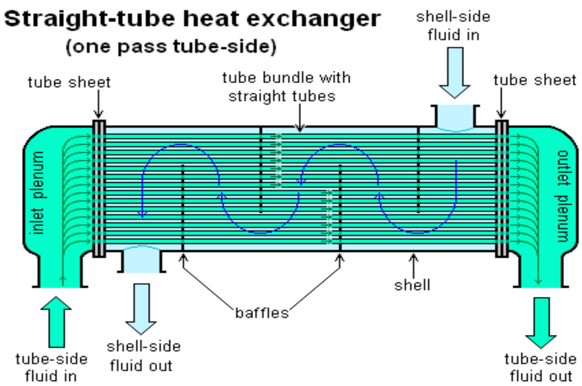

Figure 1: STHE

Nuntaphan et al. [2007] considered the result of the acclivity angle on the louvered fin and tube heat exchanger (LFTHE) in convection, which is free in nature. It was developed that the acclivity gradient plays an important place on the implementation of LFTHE. The execution of the heat exchanger is related with the interconnections between the louver, tube as well as acclivity angle. The heat transfer potential substantially reduces with ascent in the acclivity angle. This reduction in heat transfer potential is because of the hindrance of the vane and its backward dissipating heat movement against the rising air. However, at an acclivity inclination of 30 degree to 45 degree, a substantial improvement of heat transfer potential was observed. It happened because,

substantial quantity of air was forwarded by the louver, resulting in ‘‘louver- directed” effect, as seen in convection which is forced in nature. Due to supplementary upsurge of the acclivity angle, the hindrance result is strong enough as to counteract the ‘‘louver-directed” process. In contrast with forced convection, the heat transfer potential reduced as the tube row increased. Gang Lei [2008] perpetrated quantitatively and innovatively the execution of a heat exchanger in the company of coiled obstruction. CFD procedure was used to reproduce the heat exchanger with coiled obstruction. The investigation was organized with hot oil on the side of shell and cool water on side of tube. They explored that the CFD forecasts could be counted on in the enactment of current geometric layout. Kumar, Jaya et al. [2008] perpetrated innovative and quantitative explorations on heat transfer in helically coiled heat exchangers considering conjoin heat transfer and thermal supported effects of heat transport media. HTC of the heat exchanger was deliberated using the Fluent 6.2. The CFD predictions were considerably good in agreement with the innovative outcomes within innovative erratum limits. Li and Wang [2010] conducted an innovative survey on the airside transfer of heat and drop of pressure attributes for Br - Al heat exchangers with multiple-area louvered vanes and smooth tubes. A sequence of pilot study was managed for heat exchangers with divergent numbers of louver area, at the air part R_e of 400-600 based on the louver pitch. NTU method was used to examine the air-side thermal potential details. In this survey, the associations of the j and f elements were revealed depending on geometry parameters. Lemouedda et al. [2011] quantitatively examined the transfer of heat potential of serrated finned tubes by distorting the outmost part of the vane at divergent inclination and by adjusting the number of vane components/ period. CFD simulations were performed considering the compressible nature of flow and conjugate heat transfer for Reynolds numbers between 600 and 2600 i.e. the flow over the fins was considered to be laminar. Khaled et al. [2011] developed an analytical approach using the elementary calculations for representing transfer of heat in heat exchangers, to determine the thermal potential of air cooled cross-flow heat exchangers. A 2 - D computational code is also generated to assess the heat exchanger potential.

OBJECTIVES

- To study the pressure distribution using Fluent as a tool
- Comparative analysis of heat transfer using water and Nano fluid

COMPUTATIONAL MODEL

The computational model of STHE is shown in the figure below with inlet and outlet.

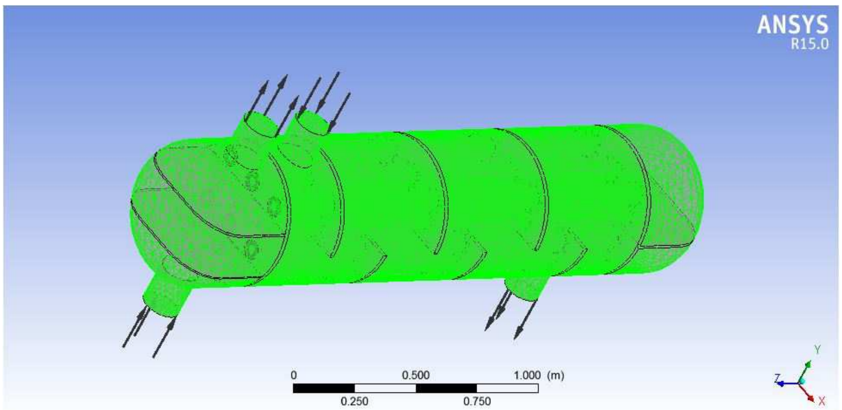

Figure 2: Computational Model of STHE

METHODOLOGY

- ANSYS is used for the simulation of STHE. Geometry is drawn in solid works and simulation is performed in fluent.
- Geometry related to problem is identified
- Meshing is done which may be uniform or non uniform
- Outline the boundary conditions
- Start the simulation work.
- Analysis of the problem.

Script File

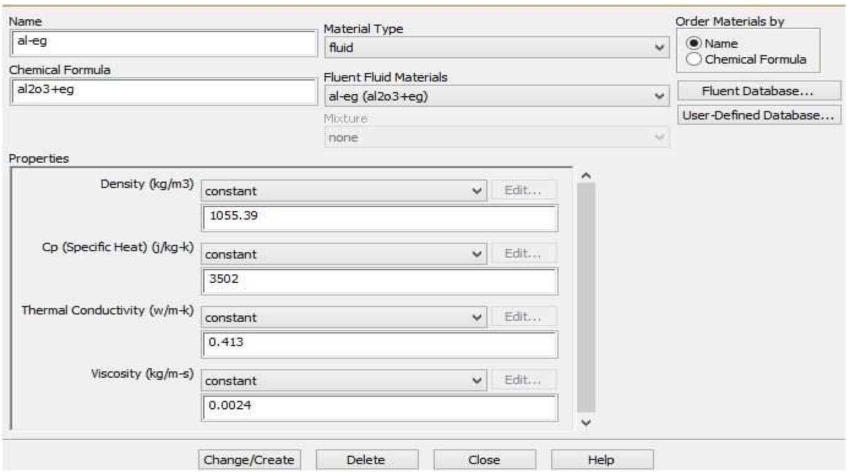

Figure 3: Input Properties for Aluminum Oxide (Al_2O_3)

RESULTS AND DISCUSSIONS

Variation of Pressure

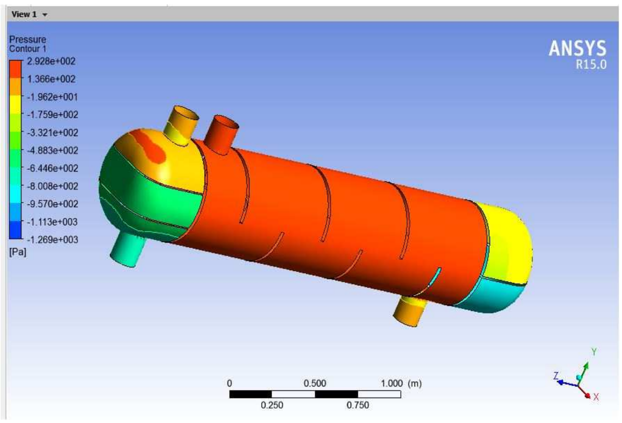

Figure 4: Pressure Arrangement across STHE (Water)

The pressure arrangement along the STHE (Water) is shown in the figure 4. The pressure at entrance of the hot fluid is 2.928 Pa, and at the outlet is 1.759Pa. The pressure at the entrance of cold fluid is 1.962Pa and at outlet it is 4.883Pa.

Variation of Eddy Viscosity

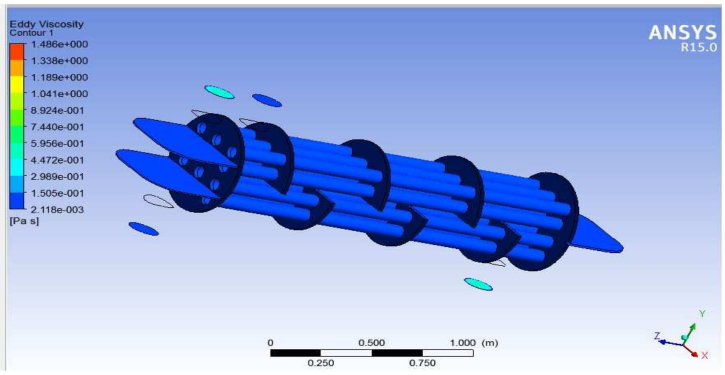

Figure 5: Eddy Viscosity Distribution across Heat Exchanger (Water)

The viscosity distribution along STHE (water) is shown in the figure 5. The viscosity at inlet of the hot fluid is 2.118 Pa s, and at the outlet is 2.989Pa s. The viscosity at the inlet of the cold fluid is 4.470Pa s and at the outlet it is 2.118Pa s.

Variation of Pressure

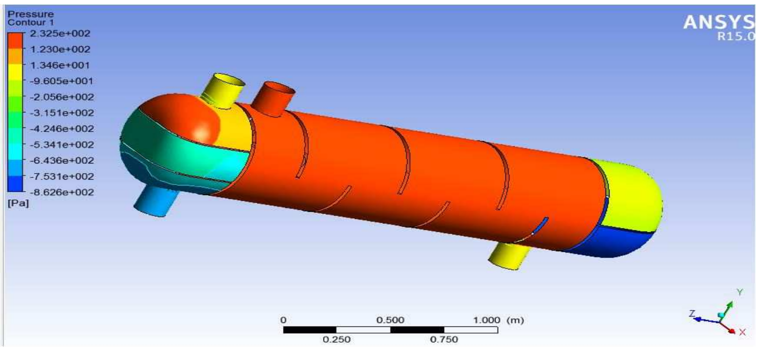

Figure 6: Pressure Arrangement across STHE (Nano-Fluid)

The pressure arrangement along STHE (Al_2O_3) is shown in the figure 6. The pressure at entrance of the hot fluid is 2.325 Pa, and at outlet is 1.346 Pa. The pressure at the entrance of the cold fluid is 1.392Pa and at outlet it is 5.341Pa.

Variation of Viscosity

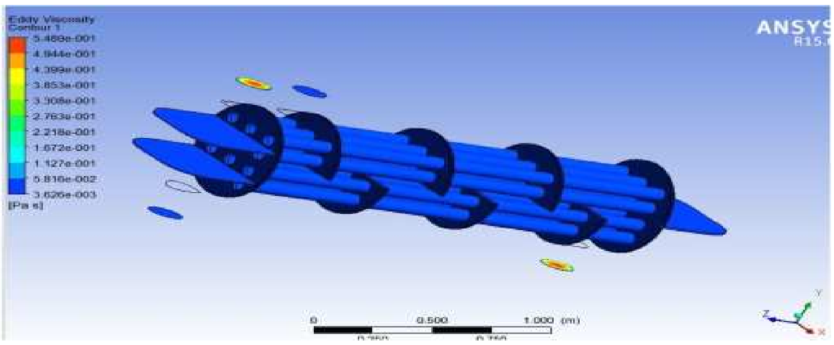

Figure 7: Eddy Viscosity Distribution across STHE (Nano-Fluid)

The viscosity distribution along STHE (Al_2O_3) is shown in the figure 7. The viscosity at the inlet of the hot fluid is 3.626 Pa s, and at the outlet is 4.944 Pa s. The viscosity at the inlet of the cold fluid is 4.399 Pa s and at the outlet it is 3.853 Pa s.

Output Results Comparison

Temperature

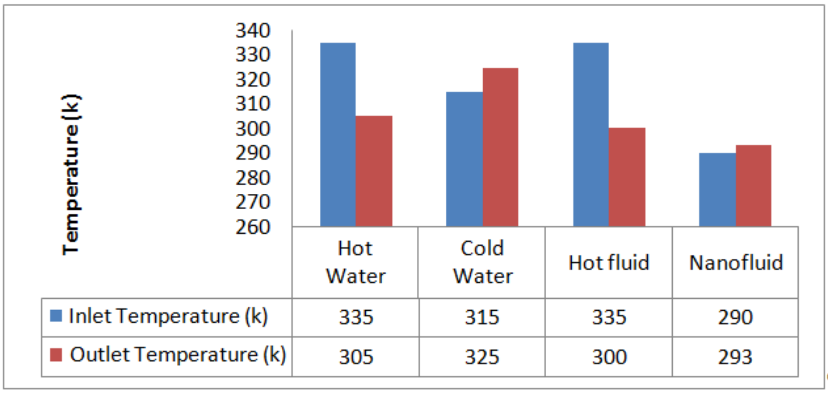

Figure 8: Temperature Differentiation for Water and Al_2O_3

Figure 8 shows the Temperature differentiation for water and Al_2O_3. The results show that the variance in temperature at entrance and the outlet is high in using nano fluid compared with the water.

Pressure

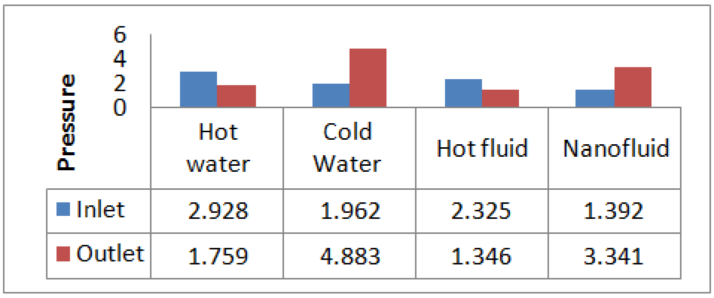

Figure 9: Pressure Differentiation between Water and Al_2O_3

Figure 9 shows the pressure variance between the water and Al_2O_3.

Velocity

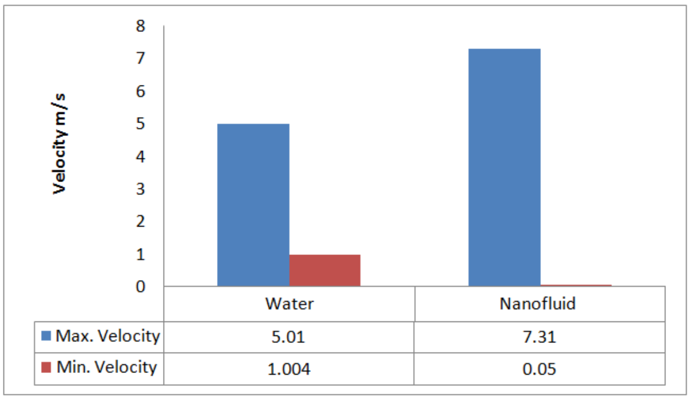

Figure 10: Velocity Differentiation between Water and Al_2O_3

Figure 10 shows the velocity variance between the water and Al_2O_3. The results show that the maximum velocity is obtained in using the nano fluids.

Viscosity

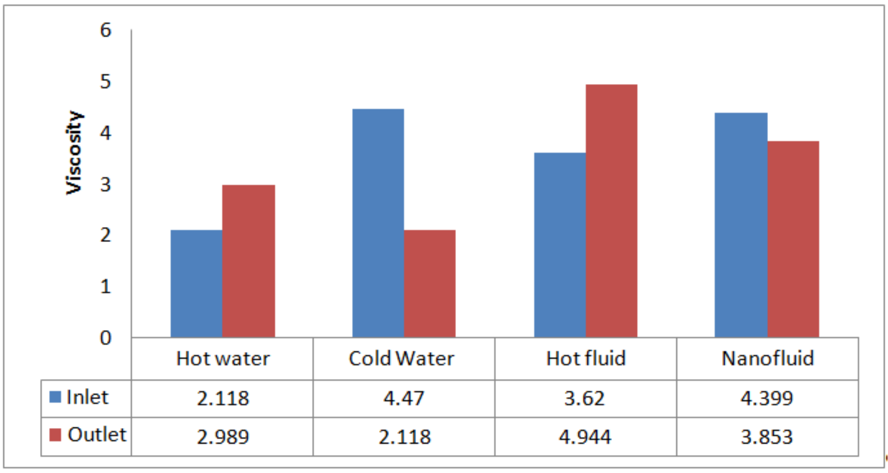

Figure 11: Viscosity Differentiation between Water and Al_2O_3

Heat Transfer Rate

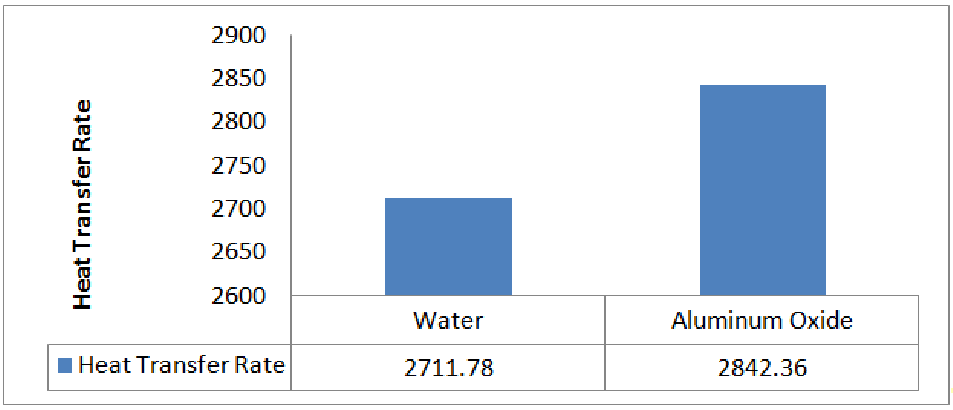

Figure 12: Heat Transfer Rate Comparison

CONCLUSIONS

The pressure distribution and rate of heat transfer is analyzed using Fluent in case of base fluid and nano fluid. It was found from the solutions that the heat carrying capacity of nano fluid is more in differentiation to base fluid. So, Al_2O_3 is having high effectiveness as compared to water. Hence, another scope for improvement is by using the different volume concentration of nano fluid.

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